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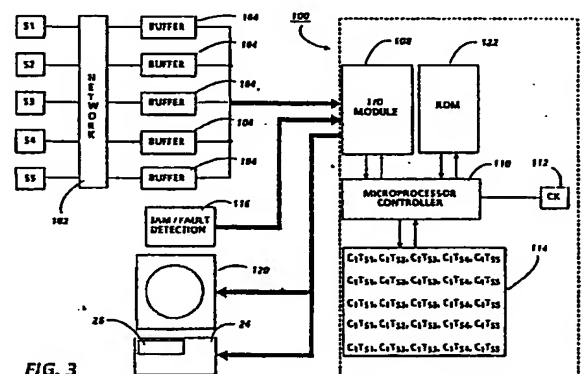
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(54) Reproduction machine with diagnostic system.

(57) A reproduction machine (10) for making copies from original documents includes a paper path through which sheets of paper are passed by transport devices during reproduction operations to various stations (A-E) in the machine for operation thereon. A diagnostic system is included for examining the operation of the transport devices moving the paper sheets through the paper path, comprising: paper path sensors (S1 - S5) located along the paper path for sensing the passage of paper sheets as they are moved therethrough; a device clock (CK) for generating information regarding the times of sheet passage past the sensors; an addressable memory (114) for storing data representative of machine operating time and corresponding to paper sheet passage past the sensors for a number of paper sheet passages; a non-volatile memory (120) for storing data corresponding to the passage of paper sheets past the paper path sensors on receipt thereof from the addressable memory, and a control (24) and display (26) for accessing and reviewing the memories containing time information representative of paper sheet passages.



Description

REPRODUCTION MACHINE WITH DIAGNOSTIC SYSTEM

This invention relates to a reproduction machine incorporating a diagnostic system for the paper path thereof.

The maintenance of complex reproduction machines has become an increasingly important aspect in the commercial production and sale of such machines. As these machines grow larger, more complex, faster and more expensive, it has become increasingly important to take measures ensuring the machines continued reliable operation. As these machines are indispensable to their users, an increasingly important feature of such machines is their reliability. When the machine does malfunction, it is desirable that it be fixed in as short a time as possible.

As a result of these needs, much work has been done to improve the on-board diagnostic capability of these machines. With such a machine capability, a service representative, or a trained user can easily and quickly determine the cause of the malfunction. In the case of a service representative, based on such a diagnostic report from the machine, action may be taken to effectuate an appropriate repair.

In the past, such diagnostic capability was restricted to use during a diagnostic mode of operation. In this type of system, as shown by United States Patent No. 4,477,901; a diagnostic system is provided for use by a service representative when the machine is not in a normal mode of operation. In such a system, the service representative can exercise certain diagnostic capabilities of the machine particularly related to the flow of paper through various paths of the machine to determine whether such paths are operating at the appropriate speed, while the machine is in a non-operable mode. Alternatively, a limited examination of paper flow paths may be made on a real time basis demonstrating the events leading to a malfunction, as shown by United States Patent No. 4,335,949. This information is lost after the problem has been corrected and operation of the machine is resumed. Often, difficult and costly problems occur only on an intermittent basis, and are difficult to replicate. Accordingly, the service representative has no information to proceed from when asked to make adjustments on a service call.

In the same manner, United States Patent No. 4,268,746 teaches comparing actual machine operation, i.e. paper passing times, with an ideal system, and creating an alarm when the system varies more than a selected amount from the ideal. Similarly, United States Patent No. 4,249,080 teaches a system for comparing detected article movement with detected surface movement. Such systems provides for detection of failure events, but not for the factors leading up to the failure event so no corrective action may be taken based on the machine malfunction indications.

It is understood that the diagnostic system of the IBM Series 3 copiers, Models 30, 40 and 60, provides stored information for later retrieval regarding the

location of paper jams occurring over time, as well as the source of paper causing the jam. This identifies the paper path which is potentially at fault, but tells a service representative nothing about the cause of the problem.

US-A- 4,589,080 suggests that sensors may be disposed throughout a machine, and machine timing monitored. However, the monitored timing is apparently for the purpose of setting fault flags, and evidently the monitoring occurs during diagnostic testing.

Xerox Disclosure Journal, Vol. 9, page 393, November/December 1984, discloses use of an adaptive algorithm for recirculating document handlers which entails using sensed document acquisition time and sensed document transport time to control the total time through the recirculating document handler. The acquisition and transport times described are sensed for each set of documents passed therethrough, and abnormalities can thus be detected.

Also, as background, US-A- 4,156,133 teaches display of "gap times" indicating time between sensors, and stores the time for contemporaneous review. US-A- 4,133,477 teaches storing fault codes for future reference.

None of the references teach a satisfactory way for a service representative to examine past successful operation of the paper paths as well as past fault operations to determine whether a problem is spontaneous or developing over time. The prior art methods of diagnostics have proven unsatisfactory in the area of preventive maintenance as previous systems have relied on the appearance of a malfunction or fault to begin the diagnostics operation, or require the service representative to work backwards from a fault to determine its source. It would therefore be desirable to provide a constant operation, real time diagnostics system, accessible at any time, and providing current operation information on a portion of the machine, as well as information on previous fault operation.

In accordance with the invention, there is provided an improved real time diagnostics system in a reproduction machine having a series of interrelated stations or chains performing the functions required by such a machine, and including a paper path having transport devices for passing material as either source material or as copy material to appropriate stations in predetermined timed sequence for operation thereon. Sensors located along the paper paths detect paper passing thereby. Information regarding this passage is stored as a time based event in a device memory for access by an operator. Event information is stored for the passage of several sheets before deletion of the earliest recorded event information in the memory. Recorded information may be accessed upon demand, either graphically or numerically, and in a fashion demonstrating the actual recorded operation of the device. Accordingly, a history of previous

operating characteristics is available to the operator, showing past successful operations of the machine, in addition to possibly malfunctioning operation.

In one embodiment of the invention, recorded information regarding previous operation of the device is stored in a device memory for subsequent retrieval and analysis upon the occurrence of a preselected condition, such as a malfunction. This information may be stored in either a semi-permanent device storage element or on a removable recording medium for later examination.

In a preferred embodiment of the invention, a device controller is provided with optimum operating parameters for device operation against which a comparison of recorded event information may be made. With this comparison, action may be taken to adjust machine operating parameters to avert potential malfunctions of the device resulting from gradual changes in the machine operation caused by part wear, dirt, or other factors preventing machine performance on a factory designed level, but not yet causing malfunctioning operation.

It is therefore a primary object of the present invention to provide an integral real time diagnostic system for the paper path of a xerographic reproduction machine, continuously operable, and providing historical operation information on a monitored portion of the machine in a manner demonstrating successful operation of the device, as well as malfunctioning operation.

It is a further object of the present invention to provide a continuously operable paper path monitor monitoring paper path operational values during normal operation thereof.

It is yet a further object of the present invention to monitor and store the characteristics of operation of a selected portion of a xerographic machine from which a history of operation thereof may be derived.

It is still a further object of the present invention to provide a diagnostics system in a xerographic machine provided with stored optimum operating parameters against which actual operating characteristics may be compared for a determination of repair or adjustment requirements.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 is a perspective view of a reproduction machine of the type contemplated to embody the present invention;

FIGURE 2 is a somewhat schematic view of the paper path of the machine in Figure 1; and

FIGURE 3 is a block diagram showing the operational elements of a preferred embodiment of the present invention.

Referring now to the drawings, which are for the purpose of illustrating a preferred embodiment of the invention and not for the purpose of limiting same, FIGURE 1 shows a perspective view of a reproduction machine as contemplated by the present invention. Reproduction machine 10 may include recirculating document handler 12, for advancing documents to be copied to the appropriate positions in processing module 14, where the reproduction processes are performed. Copy paper

stock is advanced from copy sheet holding trays 16 and 18 through the copy sheet module 20 to the processing module 14 for operation thereon. The resultant copies may then be transported to a finishing module 22 where such steps as collation, compilation, stapling, or binding may take place. Control panel 24, with display screen 26, allows the machine operator to select the various options available in the device, to start and stop copying operations and to otherwise program the machine operation. Display screen 26, in conjunction with control panel 24, allows the operator to view the selected machine conditions as well as certain control aspects of the device.

FIGURE 2 shows, somewhat schematically, the general operating arrangement of a reproduction machine of the type contemplated. Module 14 is provided with belt 30 having a photoconductive surface deposited on a conductive substrate. Belt 30 is advanced by and about driving roller 32, tensioning roller 34 and stripping roller 36. Successive portions of the photoconductive surface of belt 30 are thereby advanced through processing stations sequentially arranged about the path of belt 30.

To begin the copying process a portion of belt 30 passes through charging station A, where a corona generating device 40 charges the surface of belt 30 to a relatively high uniform potential.

After the surface of belt 30 is charged, the charged portion thereof is passed through exposure station B. At exposure station B, a document to be copied is advanced onto a transparent platen 42 by the recirculating document handling system 12. Lamps 44 illuminate the document. Light rays reflected from the illuminated document are transmitted through lens 46 forming a light image thereof. The lens 46 focuses the light image on to the photoconductive surface of the belt 30 to selectively dissipate the charge thereon. An electrostatic latent image is recorded on the photoconductive surface which corresponds to the informational areas contained within the original document.

After the electrostatic image is recorded on the photoconductive surface of belt 30, that portion of the belt holding the image is advanced to development station C. At development station C, magnetic brush development system 48 advances developer material into contact with the latent image on belt 30. Preferably, magnetic brush development system 48 includes magnetic brush development rollers 50 and 52. Each roller advances developer material into contact with the latent image. Rollers 50, 52 form a brush of carrier granules and toner particles extending outwardly therefrom. The latent image attracts the toner forming a toner powder image on the latent image.

After development, the image carrying portion of belt 30 advances to transfer station D. A copy sheet, such as paper, transparency, etc., is advanced from the copy sheet module 20. Transfer station D includes a corona generating device 54 which sprays ions onto the backside of the copy sheet. This attracts the toner particles from the photoconductive surface of belt 30. After transfer of the toner material to the copy sheet it is moved to fuser station

E.

Fuser station E includes a fuser assembly 60 for permanently affixing the transferred toner powder onto the copy sheet. Fuser assembly 60 comprises a heated fuser roller 62 and backup roller 64. The copy sheet is passed between fuser roller 62 and backup roller 64 with the toner powder image on the copy sheet contacting the fuser roller. In this manner, the toner powder image is permanently affixed to the copy sheet. After fusing, the copy sheet is advanced to either an output tray 66 or a duplex tray 68 for second side copying, or to finishing module 22 where additional operations may be performed thereon. Reproduction copying in the manner described above is well known, and so no further details will be given here.

In accordance with the invention, photoelectric or pressure sensitive sensors may be arranged at predetermined locations along the paper paths of the recirculating document handler or the copy sheet transport devices. By way of example, photoelectric sensors S1, S2, S3, S4, and S5 may be located along the paper path of the copy sheet transport devices at locations proximate to copy-sheet tray conveyor 80 carrying copying sheets outwardly from copy sheet trays 16 and 18, at the conveyor carrying copy sheets to fuser 60, at the selector gate 82, passing the paper to either of inverter 86, or to output 66, at the output tray nip 88 or at duplex tray output 90. It will be appreciated that many more sensors of various types may be used in a wide variety of locations, either in the reproduction processing module 14 or in any of the other modules.

Referring now to FIGURE 3, as a copy sheet passes by any of sensors S1-S5, its presence is detected, and a signal is sent to reproduction controller 100. Reproduction controller 100 also conventionally provides for storage and comparisons of counted values including copysheets and documents, and numbers of desired copies; and control of operations selected by an operator through control panel 24 and display screen 26, as is well known in the art. Signals from the sensors are passed via resistance network 102 through buffer 104 to an input/output (I/O) stage 108 of reproduction controller 100. Microprocessor 110 including clock 112 is provided in controller 100 for the general control of the reproduction machine systems. In response to a signal from any of sensors S1-S5, received by microprocessor 110 through I/O stage 108 from clock 112, data representative of the time at which a copy sheet passes the sensor is loaded into addressable device memory 114. Subsequent data, representative of the times at which succeeding copy sheets pass successive sensors, is loaded into sequential memory addresses. If desired, the data directed to addressable memory 114 may be arithmetically manipulated by microprocessor 110 before storage to produce differential time information, e.g. the time that a copy sheet took to pass between two predetermined sensors, or time values reflecting the period from the start of a particular copying operation.

The timing data is stored in addressable device

memory 114 of controller 100 at sequential addresses in an array relating particular copy sheets to the times of passage past particular sensors. In accordance with the invention, this information is stored and continuously updated in addressable memory 114. In practice, it is contemplated that information will be stored for a predetermined number of copy sheets, approximately 5-10 at a time. The array is updated in either a stacking or circulating fashion, deleting the oldest information on receipt of newer information. This information is accessible via the control panel 24 for display on display 26 and may be accessible in either operating, quiescent or diagnostic modes. Accordingly, an operator may view dynamic operation or past history of operation.

In accordance with another aspect of the invention, the stored array values are directed from addressable device memory 114 to non-volatile memory means on the occurrence of a fault condition detected by system fault or jam detectors 116. As shown in FIGURE 3, addressable device memory 114 is connected through microprocessor 110 to a non-volatile memory means, such as disk storage device 120. Disk storage device 120 may be either a hard or floppy disk storage device of a type well known in the art of data storage. In a preferred embodiment, floppy disk storage may be provided to enable stored data to be removed from the machine and reviewed at remote locations. It will also be appreciated that information stored at disk storage device 120 is operator accessible via control panel 24 for display on display 26.

Data stored at addressable memory 114 is passed to the disk storage device 120 on the occurrence of a fault condition generated at the jam/fault detection system 116. A signal indicative of a fault or jam condition, or data interpreted as a fault or jam condition, is passed through I/O module 108 to microprocessor controller 110. It will be appreciated that the detection of machine malfunctions, and the generation of fault signals in response thereto is well known in the art as shown by the aforementioned United States Patent No. 4,477,901. On detection of a signal from the fault /jam detection system 116 indicating a problem, microprocessor controller 110 directs the current data stored in addressable device memory 114 to disk storage device 120. At this point all values are reset and the sensing operation is recommenced on continued operation of the machine.

The controller 100 may additionally be provided to have in memory, either in a hard disk, floppy disk, or in a device memory such as read only memory (ROM) 122, a set of stored values indicative of optimum operation of the paper path transport system. In this case, the stored values may be retrieved from the ROM 122 and reviewed at display 26. It will be appreciated that this information may include either the machines historical operating characteristics, thus showing the distinctive aspects of a particular machines operation, or factory specified values for comparison with sensed operating parameters of the device stored either at addressable device memory 114 or disk storage

device 120. Arithmetic manipulation may be available through microprocessor 110 to compare sensed values with stored values thereby displaying the differences or errors in actual operation when compared to ideal operation.

The invention has been described with reference to a particular embodiment. Modifications and alterations will occur to others upon reading and understanding this specification. It is intended that all such modifications and alterations are included insofar as they come within the scope of the appended claims.

Claims

1. A reproduction machine for making copies from original documents, having at least a first paper path through which sheets of paper or other material are passed by transport devices during reproduction operations to various stations in said machine for operation thereon, and a diagnostic system for examining the operation of said transport devices moving said sheets through said paper path, said diagnostic system comprising:

paper path sensing means located along said paper path for sensing the passage of sheets as they are moved therethrough;

clock means for generating data representative of machine operating time;

addressable memory means for storing data representative of machine operating time and corresponding to sheet passage past said sensing means for a preselected number of sheet passages;

non-volatile memory means for storing said data corresponding to the passage of paper sheets past said paper path sensors on receipt thereof from said addressable memory means;

means for selectively accessing the memory means containing said time representations of said sheet passage.

2. A reproduction machine as claimed in claim 1, wherein the diagnostic system includes display means for displaying said data representative of machine operating time and corresponding to copy sheet passages in operator readable format.

3. A reproduction machine as claimed in claim 1 or 2, wherein the diagnostic system reference memory means for storing data representative of the passage of sheets past said paper path sensors and indicative of optimum operation of said transport devices; means for selectively accessing said optimum operation data; and means for selectively displaying said optimum operation time representations.

4. A reproduction machine as claimed in claim 3, wherein the diagnostic system further includes comparator means for comparing said stored optimum operation data with said sensed data; and means for selectively dis-

playing the comparison of said optimum and said sensed data.

5. A reproduction machine as claimed in claim 4, wherein said comparison comprises the difference value between said optimum and said sensed data.

6. A reproduction machine as claimed in any preceding claim, wherein the diagnostic system includes disk memory storage means for storing said data representative of machine operating time and corresponding to sheet passage.

7. A reproduction machine as claimed in claim 6, wherein said disk memory storage means includes storage media removable from said disk memory storage means for recording said data representative of machine operating time and corresponding to sheet passage thereon, whereby said recorded data may be examined remotely from said diagnostic system.

8. A reproduction machine as claimed in any preceding claim, wherein the diagnostic system includes means moving said data representative of sheet passage past said paper path sensors to said non-volatile memory means on the occurrence of a preselected condition.

9. A reproduction machine as claimed in claim 8, wherein said preselected condition includes malfunction of said transport devices.

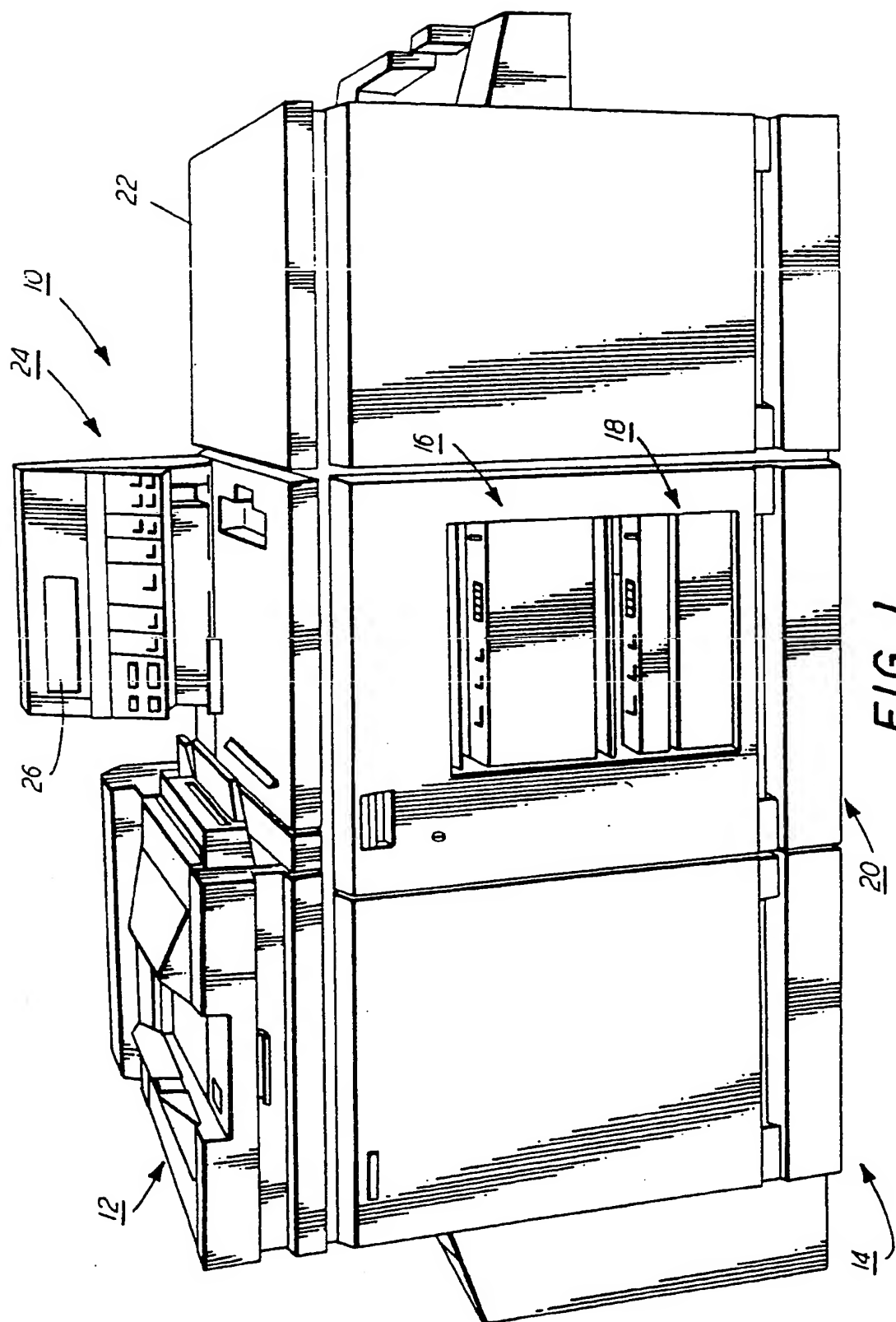
10. A method for examining the operation of a reproduction machine having at least a first paper path for circulating sheets therethrough and including paper path sensors along said paper path, including the steps of:

a. sensing passage of a sheet past paper path sensors;

b. storing information regarding the time of sheet passage past said paper path sensors in an addressable memory for a plurality of paper sheets, whereby information is stored for a series of operations of said reproduction machine;

c. continuously updating said information by deleting sheet passage information for the oldest sheet passage and adding information regarding the most recent sheet passage.

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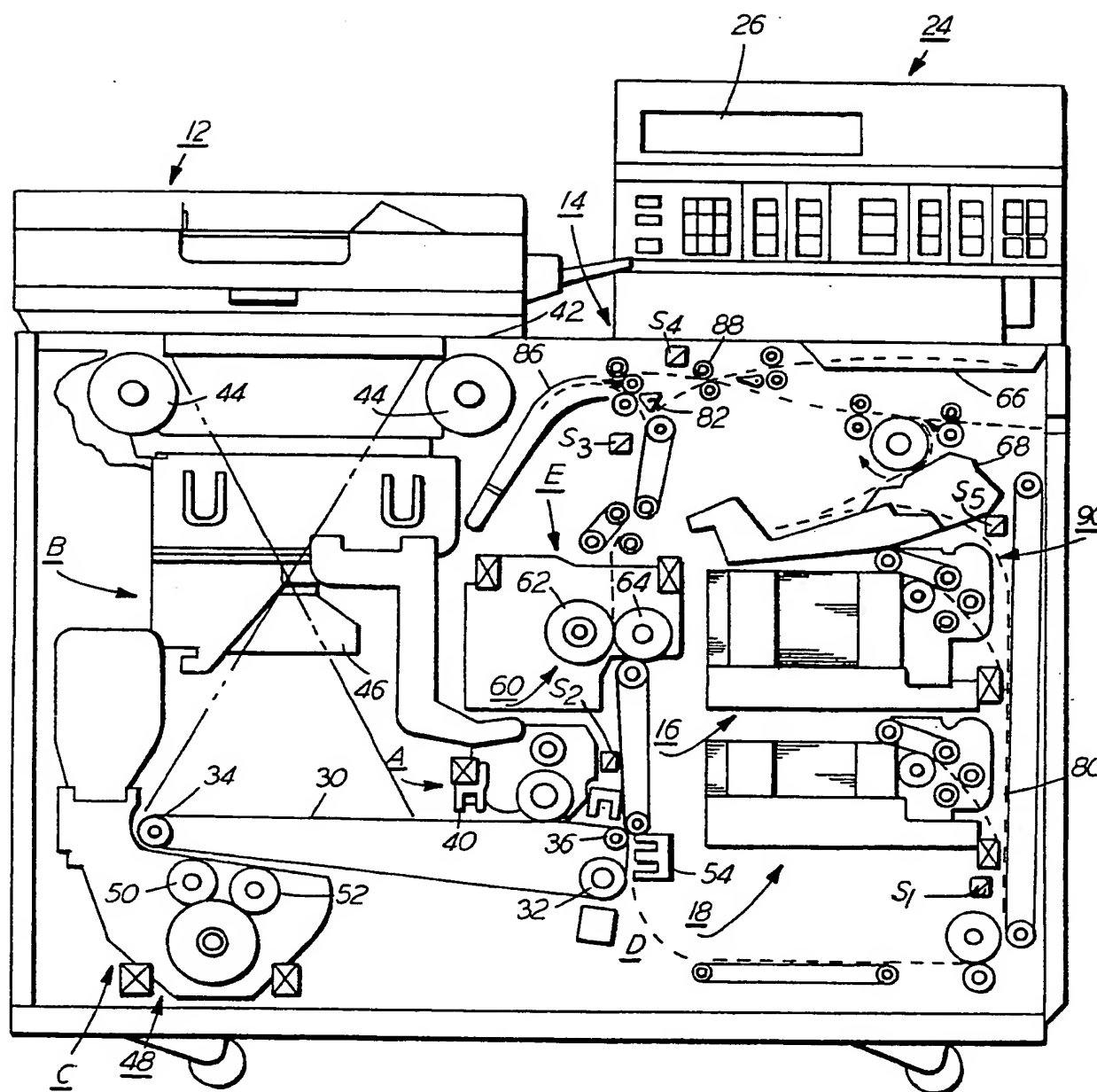


FIG. 2

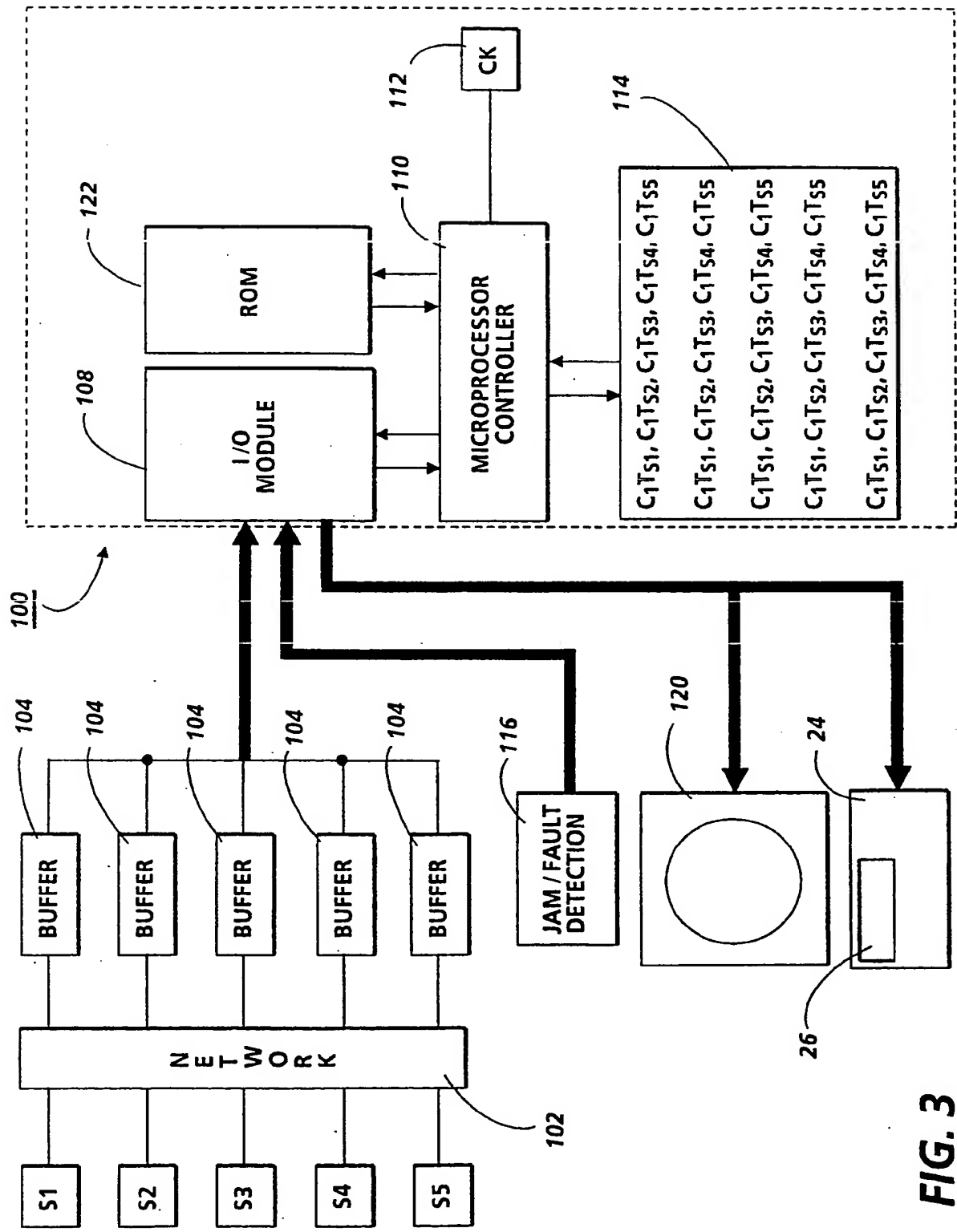


FIG. 3

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⑤4 Reproduction machine with diagnostic system.

57) A reproduction machine (10) for making copies from original documents includes a paper path through which sheets of paper are passed by transport devices during reproduction operations to various stations (A - E) in the machine for operation thereon. A diagnostic system is included for examining the operation of the transport devices moving the paper sheets through the paper path, comprising: paper path sensors (S1 - S5) located along the paper path for sensing the passage of paper sheets as they are moved therethrough; a device clock (CK) for generating information regarding the times of sheet passage past the sensors; an addressable memory (114) for storing data representative of machine operating time and corresponding to paper sheet passage past the sensors for a number of paper sheet passages; a non-volatile memory (120) for storing data corresponding to the passage of paper sheets past the paper path sensors on receipt thereof from the addressable memory, and a control (24) and display (26) for accessing and reviewing the memories containing time information representative of paper sheet passages.

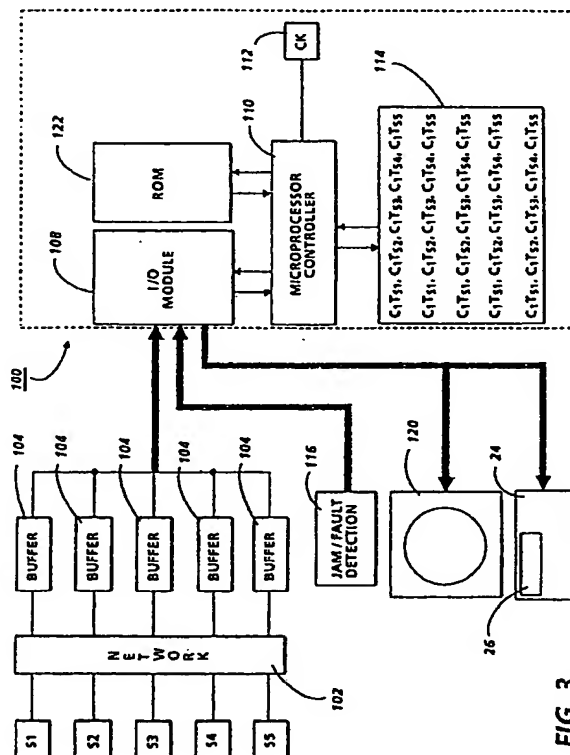


FIG. 3



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 87 30 7720

| DOCUMENTS CONSIDERED TO BE RELEVANT | | | |
|---|---|--|---|
| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.4) |
| D,Y | US-A-4 156 133 (LEGG) * Column 85, line 28 - column 87, line 3; claim 7 * | 1,2,6,7 ,8,9 | G 03 G 15/00 |
| D,A | --- | 10 | |
| Y | PATENT ABSTRACTS OF JAPAN, vol. 10, no. 3 (P-418)[2060], 8th January 1986; & JP-A-60 159 868 (FUJI XEROX K.K.) 21-08-1985 * Whole abstract * | 1,2,6,7 ,8,9 | |
| D,A | US-A-4 589 080 (ABBOTT et al.) * Abstract * | 1-5,10 | |
| A | EP-A-0 002 567 (INTERNATIONAL BUSINESS MACHINES) * Abstract * | 1,2,8,9 ,10 | |
| A | US-A-4 062 061 (BATCHELOR et al.) * Abstract * | 1,2,8,9 ,10 | |
| A | US-A-3 893 175 (SOLOMON) * Column 5, line 16 - column 6, line 60 * | 1,6,7, 10 | TECHNICAL FIELDS SEARCHED (Int. Cl.4) |
| A | US-A-4 553 830 (NGUYEN) * Abstract * | 1,2,3, 10 | G 03 G 15/00 |
| The present search report has been drawn up for all claims | | | |
| Place of search THE HAGUE | | Date of completion of the search 22-07-1988 | Examiner CIGOJ P.M. |
| CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document | | | |